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Technology in Finnish Special Education – Toward Inclusion and Harmonized School Days

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Abstract. The increasing number of children who need special education in Finland also requires an increasing amount of resources from teachers and a restructuring of the education system. Technology can be a part of the solution to this resource problem; however, for the technological solution to work, technologies need to be designed and implemented in new ways. Technologies used in special education in Finland can roughly be divided into four main categories; assistive technologies, communication technologies, and learning software. Last and the newest category concretizing technologies, such as educational robotics, have successfully been used in the Technologies for Children with Individual Needs Project. Possibilities provided by educational robotics have been extensive, not only because of the technology itself, but also because of how the technology has been implemented in innovative projects with school students. From this point of view, students with individual educational needs as well as those involved in inclusive education and harmonized school days could benefit from the use of technology.

Key words: technologies of special education, educational robotics, inclusive education, Finnish special education.

1. Special Education in Finland

For decades the education of children has been one of Finland's national priorities. Nowadays, basic institutionalised education is a natural part of every child's life. The special education system is designed to help deal with the problems that schools are confronted with as they attempt to provide a quality education to all children. The results of PISA (OECD, 2003; Institute for Educational Research, 2003) research show that the provision of special education has been effective and successful in Finland. The skills of Finnish students were among the best in all domains assessed in the PISA 2003 survey – that is, in mathematics, reading literacy, sciences and problem solving. This outstanding achievement is based, in particular, on the the comparatively high scores of typically low- or average-performing students. For example, the average score achieved by the weakest quarter of Finnish students was by far better than that of the corresponding quarter in any other country. The high level of Finland's weakest students is also reflected in the small number of students at risk. Only 7% of Finnish students had poor mathematics skills (OECD average 21%) and 6% had poor literacy skills (OECD average 19%) (Finnish National Board of Education, 2006).

Special education in Finland is given both in segregated and integrated settings. In kindergarten and preschool, children are mainly mainstreamed in regular settings. Support is given by a special education kindergarten teacher who works either with a group of children with special needs in an integrated setting or gives support to all children in a setting that has integrated children with special needs. In comprehensive school (i.e., in grades 1–9) the special education system provides services to the 1.8% of students with *severe disabilities*, who attend special schools, and provides services to the 4.4% of students with *less serious disabilities*, who are mainstreamed in regular comprehensive schools; both these groups are specifically diagnosed. A third group – about 17% of pupils – are special needs students who are not specifically diagnosed with a learning disability but simply *need additional help to keep up*. According to Norton Grupp (2006), students in this third group are the main focus of special needs teachers, although special needs teachers also provide services to students with severe or less severe disabilities.

A special needs teacher in a Finnish comprehensive school needs a comprehensive school teaching certification and one year's additional preparation in various learning problems and special education or a Master's degree in special education. In consultation with the teacher, the special needs teacher works one-on-one or in small groups with students who have not been adequately helped by other teachers. Special needs teachers usually concentrate on language (Finnish or Swedish) and math instruction.

Support for students with special needs is also given in upper secondary education. Finnish upper secondary education has two tracks: general education and vocational education. The principal objective of general upper secondary education is to prepare students for the matriculation examination. The principal objective of vocational programs is to foster students' vocational competence. The provision of special education in upper secondary schools is similar to special education in comprehensive schools. Special vocational schools serve students with profound and severe disabilities. Students with less profound or minor special needs attend regular vocational education or upper secondary schools but get support from a special needs teacher. Nevertheless, the proportion of special needs teachers to special needs students in upper secondary schools is still minor compared to the proportion in comprehensive schools. The number of students with special needs in upper secondary education has gradually increased. In 2000, 8.2% of upper secondary students needed special education. In 2004 the number was 10.5%.

Regardless of the excellent results in international surveys and success in organizing special education services, the Finnish school system is currently facing many challenges. The movement to integrate students with special needs into normal school classes started in Finland in the 1960s. The progress of integration has been ongoing but slow, because it has required changes and adjustment in teachers' attitudes, teaching methods and practices, as well as changes in the materials and equipment used. In this ongoing and challenging situation, educational technology has been one important element facilitating integration.

The goal of this paper is to give a brief overview of the role and uses of technology for special education in Finland. This far, most of the special education technologies have aimed at supporting students with *physical* deficiencies. However, *cognitive, emotional* as well as *social* impairments are becoming increasingly common among Finnish students. In this paper, special emphasis will be given to the introduction of robotics in special education, as it has been shown to be a promising technology for addressing these needs (Kärnä-Lin *et al.*, 2006; Sutinen *et al.*, 2005). We will also explore the ways that technology can support needs behind the idea of a harmonized school day – a school day that is coordinated with the working hours of students' parents. Students are not left home alone during working hours, but they can choose whether they spend this time either at schools or at home.

2. Use of Technologies in Special Education in Finland: Four Approaches

According to our experiences in the Developing Project for Technology Education[1], the Technologies for Children with Individual Needs Project[2] and discussions with numerous teachers, technologies are on average made good use of in the Finnish special education. However, those technologies are rather traditional and based on various interface devices or entry-level uses of information and communication technologies (ICTs). Their purpose is typically to facilitate daily activities or to improve learning. Those technologies can be divided into four main groups: 1) assistive technologies, 2) communication technologies, and 3) software for supporting one's learning. In addition, a small number of schools use 4) concretizing technologies, such as educational robotics, to support learning and to implement schoolwide curriculum. Unfortunately, nationwide statistical information about the degree of use of technologies in special education is not available in Finland.

In the following sections, we briefly describe the four central categories of technologies used in special education in Finland. This description is not meant to be comprehensive, but simply an overview of the topic. The categories have mainly been used as a framework to get an overall picture of the field in the Technologies for Children with Individual Needs Project.

2.1. *Assistive Technologies*

In special education, assistive technologies are tools or instruments that improve the capacity, independence and initiatives of individuals (Salminen, 2003). They are primarily

[1]Developing Project for Technology Education (European Social Fund, under grand ISLH-2002-04159/Ha-7)

[2]Technologies for Children with Individual Needs Project (European Social Fund, under grand ISLH-2005-01363/Ha-7)

used when a sickness or a disability has decreased the level of an individual's activity or participation in society. Assistive technologies, in general, help individuals hear, see, communicate, move, live, work, study, or play. They range from walking sticks and magnifying glasses to speech synthesizers and highly-developed computer systems. Those devices include both personal and general instruments, such as personal hearing aids or induction loops.

According to Finland's Basic Education Act 628/1998, handicapped and other children with special needs have a right to get interpretation and assistance services free of charge, including suitable technical devices that facilitate learning. This includes individual technical tools that assist action in everyday situations as well as materials and tools that support communication and learning. In Finland assistive technologies are, in general, easily accessible and widely used. However, no precise statistical information on the number of tools and instruments used in Finland is available.

2.2. *Communication Devices*

Communication is a crucial factor in teaching and learning. However, all people are not able to communicate through speech. Communication can be aided by devices that support speaking, writing and reading. In schools, augmentative and alternative communication (AAC) is widely used in special education. AAC refers to a) communication methods that clarify speech or support the learning of speech and b) non-verbal communication through using signs. People using AAC methods can apply two kinds of devices: traditional and technical. The traditional devices include, for example, simple communication boards and folders. The technical devices include, for example, electronic speech devices and computer-based communication programs (Communication and Technology Centre Tikoteekki, 2006).

Technical devices provide a variety of ways to support communication. For example, by using a computer, a person with a speaking disability is able to communicate with others and has an instrument for rehabilitation, learning, playing, working, or managing the environment. In addition, computers, mobile phones, vision phones and video conferencing systems of the future will provide more variety in electronic communication (Salminen, 2003), both in school and home environments.

Only a few studies have investigated the use of communication devices in special education in Finland. However, these studies have convincingly shown that communication devices strongly benefit their users. For example, computer augmented communication benefited interaction, play and school work of severely disabled speech impaired children (Salminen, 2003). At the same time, there are deficiencies in the usability and availability of telematic and communicative devices (Salminen, 2003; Topo *et al.*, 2000). In general, the use of technical tools for communication increased rapidly in the 1990s and nowadays there are about 70 different types of communication tools available in Finland (Salminen, 2003). In the future, new technical devices will offer a wider spectrum of instruments for more unique and individualized applications.

2.3. *Learning Software*

Learning software; such as computerized drills, tests, tutorials and intelligent tutoring systems; supports learning. Drills are typically used for practicing calculation, the vocabulary of foreign languages, or other mechanical training through multiple choice tasks or puzzles. Computerized tests with multiple choice tasks or simple questionnaires can be used instead of ordinary school exams, and tutorials initiate typically into a new subject matter (Meisalo *et al.*, 2003). School students with learning disabilities usually need iterative training to gain competence at academic skills like reading, writing, mathematics, and problem solving. Thus, the drill types of learning tasks are effective in skill-building. Also educators' attitudes about learning software have been mainly positive and a drill-based computer-aided instruction has been shown to benefit students with learning disabilities. Well-known learning software with Finnish versions for special education includes, for example, Lexia[3] and Dyslex[4] for practicing reading, writing and cognitive skills, and multiple versions of Cami[5] for practicing mathematics and perceptual skills. These types of software can be used as practice tools, but they also provide statistical information and level of student's progress for a teacher to follow and assess student's development.

According to our knowledge, Special Education learning software is generally well known and quite widely used in teaching among teachers and other specialists of education in Finland. However, we have observed they do not pay enough attention into the individual needs. Thus, there is the lack of meaningful learning software for minor groups of school students, such as autistic children or children with severe disabilities. The content and purpose of the software does not attract or advance enough these school students.

2.4. *Educational Robotics as a Concretizing Tool*

Concretizing technologies refer to physical technical artifacts; construction sets, programmable building blocks and educational robotics; that help make one's mental models and ideas concrete. Concretization can happen, for example, by physically constructing an object; for example an elevator, vehicle, or imaginary device; and then writing a computer program to control it. Educational robotics sets; such as programmable LEGOs[6], ELEKIT[7], Sony Aibo[8] and Vex Robotics[9]; are examples of concretizing technologies that can be used together with programming to create technology artifacts for deepening and conceptualizing one's ideas. Commercial educational robotics sets range from ready-made robots to self-made robots made from plastic, metal, and electronic components. There is often a lack of compatibility between different sets, which means that usually

[3] Lexia, e.g., URL: `http://www.lexialearning.com/` and `http://www.compaid.fi`
[4] Dyslex, URL: `http://www.compaid.fi`
[5] Cami, e.g., URL: `http://www.camiweb.com/`, `http://www.compaid.fi`
[6] Lego Mindstrorms, URL: `http://mindstorms.lego.com`
[7] ELEKIT, URL: `http://www.elekit.co.jp/english/index.php`
[8] Entertainment robot Aibo: URL: `http://www.jp.aibo.com/`
[9] Vex robotics, URL: `http://www.vexlabs.com/`

only one set can be used at a time. Also, the flexibility for building different kinds of robots varies between building sets.

Educational robotics make it possible to concretize models and functions, with hands-on experience, so that models can be observed, evaluated and developed both on conceptual and on concrete levels. Thus, by building, programming and documenting in technology projects, school children can learn design, logical thinking, problem solving, technical skills, programming and ICT skills, verbal skills, and social skills, among others. Typically educational robotics, such as programmable LEGOs, are used as a part of general education schools' technology education curriculum. However, educational robotics as a concretizing tool is rarely used in special education, even though it has been found to support school students' learning and to decrease the barriers of learning. (Miller *et al.*, 2000; Sutinen *et al.*, 2005).

2.5. *Summary*

Table 1 summarizes the four approaches to using technologies in special education. It is important to note that many of currently available technologies, such as smart technologies for adaptation or adaptability, embedded or ubiquitous technologies, language technologies, agent technologies, and technologies supporting multiple representations

Table 1

The four approaches of using technology in special education. Abbreviations: Main target group (see Section 1): 1 = severe disabilities, 2 = less serious disabilities, 3 = students with occasional special needs. Disability addressed: P = physical, C = cognitive, S = social, E = emotional. School level: C = comprehensive, G = general upper secondary, V = vocational upper secondary

Technology	**Main target group (1,2,3)**	**Disability addressed (P,C,S,E)**	**School level (C,G,V)**	**Tools**	**Subjects**
Assistive technology	1, 2	P, C	C, G, V	e.g., walking stick, special keyboard and mouse	Any school subject
Communication devices	1, 2	P, E, C	C, G, V	e.g., PCS-symbols, pictogram, and Bliss symbols	Any school subject that requires, e.g., reading, writing, and talking
Learning software	2, 3	C, S, E	C, G, V	e.g., Lexia, Dyslex, Cami	Any school subject that requires, e.g., reading, writing, mathematics, perception
Concretizing technologies	2, 3	C, S, E	C, G, V	Educational robotics, e.g., programmable LEGOs and VEX robots	Especially science and technical subjects

such as visualization or auralization have not been covered in this article, although they are obviously relevant to the field of special education.

3. Toward Future Models of Education

The future Finnish school system, particularly the comprehensive school system, will face new challenges. The far-reaching goal of the integration movement is full inclusion. If the integration movement is succesful, all children will be educated in regular settings. The goal is hard to achieve and will require much from school administrators and other school workers. Along with the integration and inclusion of children with individual needs, the notion of the harmonized schoolday is a frequent topic of conversation in comprehensive schools. The notion of harmonizing school days emerged because parents and professionals were worried about students' low motivation and interest in school attendance (Pulkkinen and Launonen, 2005). In practice, harmonizing would mean longer schooldays with more extra-curricular and leisure-like activities. This, for one, would require a great deal of variety and innovation in educational methods, materials and environments. So far the idea of harmonization has been tested in several comprehensive schools and the results have been encouraging. If the harmonized school day is implemented in comprehensive schools, educational technology, for example robotics, could play an important role in implementing new, harmonized learning environments.

A major, if not the main, criticism against the harmonized schoolday is that it is a fixed concept. The idea of all schools operating throughout the whole working day might fit the concept of a traditional 8-to-4 job, but is certainly outdated with respect to the modern, flexible work schedule. It is also worthwhile to note that the appropriate use of technology can contribute to a more flexible or relaxed realization of the harmonized school day.

A flexible reconceptualization of a harmonized schoolday makes use of ubiquitous technologies, mobile computing, and robotics, in addition to the traditional uses of ICTs at school. These technologies can be used to tackle problems related to low motivation, loneliness, social marginalization, and indifferent attitudes towards school. The main idea is to blur the boundary between school and other sectors of life, in the spirit of apprenticeship and life-long and life-wide learning. On one hand, a meaningful learning environment can also be created outside the traditional school, but on the other hand, home-like activities can be extended into the school as well. These opportunities, facilitated by new technologies, should be seriously considered when renewing the school in a way that can benefit those who are, or at risk for becoming, socially marginalized.

There are already some successful examples in Finland such as Activity School and Work-oriented Comprehensive Education where most of the academic goals and activities are tightly linked with practical training. These examples show that a meaningful learning environment can also be created outside the traditional school and, in the future, technologies could be used to facilitate ways of providing education that are more flexible. In summary, opportunities, facilitated by new technologies, should be seriously considered when renewing the school in that way that it can better support those in who are, or are at risk for becoming, socially marginalized.

4. Project Overview: Technologies for Children with Individual Needs

The lack of the technologies that pay attention to individual needs and the unrealized possibilities of those technologies provided by educational technology tools for special education (Sutinen *et al.*, 2005) were the reasons for launching the Technologies for Children with Individual Needs Project. The objectives of this research and development project were to develop both technologies and methods for learning from the fields of educational technology and special education viewpoints, and to use the Kids' Club[10] model (Eronen *et al.*, 2002). In the project, diverse groups of school students have used the tools of educational technology, such as educational robotics, to improve their learning since September 2005. The project is able to take a wide view of the needs of special education and educational technology because of its approximately 80 participants. The participating groups vary in a) age: from 6 to 18, b) level of education: from pre-school to elementary school and vocational special education, and c) individual needs: from minor learning difficulties to severe mental retardation. The educational technology tools and software have been chosen according to the students' individual needs, their personal curricula and the school curricula. Concretizing technologies (e.g., LEGO Mindstorms and ELEKIT), the LEGO RIS programming environment, Virre – a feedback and communication tool (Eronen *et al.*, 2002), media tools and learning software (such as Cami Perception Skills Builder) have been in active use by school students in their technology projects and in their lives in general. In addition, new applications, such as music and face perception tools, have been implemented in the project according to the observed needs and feedback from school students and teaching staff.

One of the project objectives is to develop computer applications for special education students according to their individual needs. Various learning disabilities also determine what is required of the programming environments, which vary from text-based editors to graphical programming environments. In students' technology projects, programming is a tool to control the technology artifacts (i.e., robots and devices) and make them move. Thus, the importance of having a programming environment that pays attention to students' individual needs is obvious. To meet this need, the project will create a programming tool, utilizing partly existing technologies, that makes programming possible by using concrete programming blocks, which are laid out on a table, for creating a computer program. A screen view is created on the computer by taking an image of the table and the blocks. Each block presents one function in the program and connecting the blocks creates the program. There is no need to use a mouse and a computer together in the programming of the concrete blocks. Also, there is no need to study symbols in the computer interface. Thus, school students can concentrate on understanding of the functions of the device and the basic structures of programming through this hands-on experience.

The technology projects, which school students implement during a school year, have provided a platform to practice technical, cognitive and social skills, among other skills, but also empowered students to give feedback and put their creativity and self-expression

[10] Kids' Club, URL: `http://cs.joensuu.fi/kidsclub/`

Table 2

Some findings and recommendations for the future from the Technologies for Children with Individual Needs Project

	School students	Teachers	Researches and developers
Technology viewpoint	Flexible building sets enable students to build various technology artifacts and facilitate creativity and alternative solutions. Programming gives students the possibility to control a technology, not only to use it. Special software is needed for children with autism and severe disabilities. Computers and software can be used at school and at home.	There is a need for a communication and feedback tools that do not require constant support by teachers or assistants. Teacher education is lacking in studies of programming. Teachers lack the time to seek information about new technologies.	There is a need to develop a flexible building set and programming and communication tools. Development cycles should be as short as possible. Programming environments should support various learning disabilities. Technologies and methods with the target group should be developed.
Pedagogy viewpoint	Building sets support inventive learning, problem solving and social interaction with others. Programming increases motivation and enthusiasm and raises learning to the next level. Collaboration with experts helps update knowledge and opens possibilities for talented children.	Going towards inventive learning and project-based learning at schools requires basic knowledge about ICT and technologies generally and the courage to try open-ended projects and unknown solutions. Collaboration with experts helps update knowledge.	Supplementary education and instructions to teachers for using technology in creative and inventive ways should be provided. Children are able to give feedback. However, meaningful and effective solutions need to be found.

skills to use (Kärnä-Lin *et al.*, 2006). At the same time, these children and young people have put the technology to the test and tried its limits, which has provided valuable and immediate feedback for R&D. Some concrete findings and needs are presented in Table 2.

5. Conclusions and Future Challenges

Our brief analysis of using technologies in special education in Finland indicates that the field is almost untouched, at least in terms of the use of advanced technologies for students with cognitive or social deficits. We also found that technologies have many possibilities for improving learning and teaching, but those possibilities are, generally, not being realized. The lack of resources, both economic and human, was observed to be the cause for the occasionally low use of the technologies.

Developing and analyzing technologies for special education is also a fundamentally technical task. In the area of special education, a technically-oriented research group can make use of challenging real-life contexts for inventing advanced tools and environments. Special education forces technical R&D to identify problems because learning difficulties are easier to recognize than in regular education. Thus, the special education class is a real-life laboratory, but also an ethically-sound research area.

However, special education can never be organized from a solely technology-driven perspective. Rather, technologies for special education should be designed and analyzed in a scenario-based way, so that an interdisciplinary approach is taken into account in both aspects. This guarantees creative design and the implementation of technologies in communities that have real needs.

In terms of research spin-offs, there are many possibilities. Creating research spin-offs requires, however, that researchers and teachers are sensitive to unexpected benefits and outcomes. For example, the observation that learning programming with robotics contributes to improving social skills was quite novel and encouraging.

Special education is constantly threatened by being defined too narrowly. The field should also cover the needs of particularly talented children for whom ordinary school requirements are too low. Those students should be offered meaningful tasks that help students orient to their future careers. An example of this approach is the ViSCoS program[11] (Suhonen and Sutinen, 2005), which offers university level CS studies to high schools students. An indication of the unexpected results of this program is its future application as ViSCoS Mobile for disadvantaged schools in South Africa.

In the future, technology will provide students with individual educational needs with increasingly more opportunities, if both concepts – technology and special education – are understood widely enough. At least the following challenges await:

1. Advancement of emotional problems, due to addictions (net, drugs etc.), suicidal behavior, and eating disorders.
2. New marginalized groups, like school drop-outs and young unemployed.
3. The changing population, due to aging (Alzheimer's disease) and immigration.
4. Isolation due to various causes, like war, HIV/AIDS (social stigma), and pandemia.

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[11] ViSCoS, URL: `http://www.cs.joensuu.fi/viscos/?lang=eng`

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Technologijų vaidmuo Suomijos specialiajam mokymui – link integruotos ir harmoningos mokyklos

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Nepaisant gerų Suomijos rezultatų atliekant tarptautinį studentų vertinimo projektą (PISA), didėjantis moksleivių, kuriems reikia specialiojo mokymo, skaičius reikalauja ir gausesnių mokytojų disponuojamų išteklių, ir švietimo sistemos pertvarkos. Technologijos iš dalies gali pasitarnauti sprendžiant šią išteklių problemą. Siekiant, kad taikomos technologijos duotų rezultatų, jos turi būti kuriamos ir įgyvendinamos pasitelkus naujus metodus. Suomijos specialiajam švietimui taikomos technologijos sąlyginai skirstomos į tris kategorijas: pagalbinės technologijos, komunikacinės technologijos ir mokomoji programinė įranga. Be to, pastebėtina, jog šiuo atveju ir techninės priemonės, pavyzdžiui, mokomoji robotų technika, gali būti sėkmingai panaudojama, kuo buvo įsitikinta atliekant projektą „Technologijos specialiųjų poreikių vaikams“. Tokiu būdu technines priemones galima laikyti nauja, ketvirtąja šios srities kategorija. Mokomosios robotų technikos suteikiamos galimybės yra ganėtinai plačios ne tik dėl šios technologijos pačios savaime, bet ir dėl būdo, kuriuo ši technologija buvo pritaikoma įgyvendinant inovacinius projektus, skirtus mokiniams. Šiuo požiūriu, tokia technologija gali pasitarnauti tiek specialaus švietimo poreikių turintiems mokiniams, tiek ir tiems, kurie dalyvauja integruoto švietimo ir harmoningos mokyklos programose.